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Japanese Patent

Hei 9-41213

HELMET

[Herumetto]

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Claims

1. A helmet, characterized by the fact that in a helmet formed of a material being constituted by impregnating and curing a thermosetting resin in a laminate having a layer composed of glass fibers and a layer composed of an unwoven fabric containing high-strength polyethylene fibers, short fibers of the high-strength polyethylene fibers with a fiber length of 20-80 mm are included at 50 vol% or more in the fibers constituting said unwoven fabric; the Metsuke of said unwoven fabric is 150-400 g/m^2; and the bulk density measured at a compressive load of 5 kg/cm^2 is 0.3 g/cm^3 or more.

2. The helmet of Claim 1, characterized by the fact that said unwoven fabric is a hybrid unwoven fabric composed of glass fibers and said high-strength polyethylene fibers or a combined-filament unwoven fabric composed of vinylon fibers and said high-strength polyethylene fibers.

Detailed explanation of the invention

[0001]

(Industrial application field)

[1] Numbers in the margin indicate pagination in the foreign text.

The present invention pertains to a helmet. For example, the present invention pertains to a helmet for protecting the head from an external impact, especially a helmet being mounted for protecting the head of a vehicle driver and passengers from the impact being applied by vehicle accidents.

[0002]

(Problems to be solved by the invention)

As helmets, especially helmets for riding on cars, which are mounted when riding on vehicles, a helmet formed of a glass fiber-reinforced resin composite material has been used. Also, for lightness, a helmet in which glass fibers and organic fibers such as vinylon are combined is proposed. Furthermore, a helmet in which glass fibers and high-strength organic fibers are combined as described in Japanese Kokai Patent Application No. Hei 4[1992]-25445 has recently been proposed.

[0003] However, as a material of the helmet using organic fibers for lightness, since common organic fibers had been initially used, the amount of glass fibers being used could be reduced, however the amount of organic fibers being used was increased to compensate the strength deficiency, so that the thickness of the hat body was increased. Thereby, the lightness was difficult to be realized. Under this situation, using high-strength organic fibers were reviewed, and a helmet in which common fiber linen

and silk and high-strength fiber linen and silk were laminated was also developed. However, the lightness level was not sufficient. Then, a helmet in which a marked lightness was realized by replacing all the common fibers with high-strength fibers and the impact resistance and the penetration resistance were also excellent was proposed, however in said helmet, the impact absorption power was easily lowered with the increase of the impact times. Thus, this helmet was not sufficiently satisfactory.

[0004] The purpose of the present invention is to solve the problems of the above-mentioned conventional helmets and to provide a helmet in which the lightness is sufficient and the decrease of the impact absorption power against a repeated impact is suppressed.

(Means to solve the problems)

The present invention is a helmet having the following characteristics.

(1) A helmet characterized by the fact that in a helmet formed of a material being constituted by impregnating and curing a thermosetting resin in a laminate having a layer composed of glass fibers and a layer composed of an unwoven fabric containing high-strength polyethylene fibers, short fibers of the high-strength polyethylene fibers with a fiber length of 20-

80 mm are included at 50 vol% or more in the fibers constituting said unwoven fabric; the Metsuke of said unwoven fabric is 150-400 g/m^2; and the bulk density measured at a compressive load of 5 kg/cm^2 is 0.3 g/cm^3 or more.

(2) The helmet of the above-mentioned (1) characterized by the fact that said unwoven fabric is a hybrid unwoven fabric composed of glass fibers and said high-strength polyethylene fibers or a combined-filament unwoven fabric composed of vinylon fibers and said high-strength polyethylene fibers.

[0006] In the present invention, as the "high-strength polyethylene fibers," polyethylene fibers with a tensile strength of preferably 25 g/d or more, more preferably 30 g/d or more are mentioned. Said tensile strength is measured by JIS L 1017. As these high-strength polyethylene fibers, for example, fibers obtained by methods described in Japanese Kokoku Patent Nos. Sho 64[1989]-8732, Hei 1[1989]-24887, etc., are mentioned. Also, the "high-strength polyethylene fibers" have an elastic modulus of preferably 800 g/d or more, more preferably 1,000 g/d or more. The tensile elastic modulus is measured by JIS L 1017.

[0007] Also, the "high-strength polyethylene fibers" have a specific gravity of preferably 0.92-0.98, 0.96-0.98, and about 0.97. Thus, the bulk density of the unwoven fabric can be lowered, and the helmet can be lightened.

[0008] In the present invention, it is important to use the unwoven fabric composed of the high-strength polyethylene fibers with a fiber length of 20-80 mm, preferably 30-60 mm. If the fiber length is smaller than 20 mm, a sufficient penetration resistance effect cannot be obtained, so that such a helmet cannot be used. If the fiber length is greater than 80 mm, the effect for stopping the impact propagation is weak, and the repeated impact resistance is deteriorated. Also, in the present invention, it is also important to use the unwoven fabric. In case a woven fabric is used, since an impact is easily propagated over a wide area, the impact resistance is excellent, however if the impact is spread, peeling-off is also spread, so that the impact absorption power is largely lowered by increasing the impact times. Thereby, the purpose of the present invention cannot be achieved.

[0009] As the unwoven fabric being used in the present invention, an unwoven fabric composed of only the high-strength polyethylene fibers may be used, however other fibers may also be combined. An unwoven fabric mixed with other fibers includes 50 vol% or more, preferably 60 vol% or more short fibers of said high-strength polyethylene fibers. If the short fiber content of said high-strength polyethylene fibers is less than 50 /3 vol%, the absolute strength of the hat body of the helmet, and

it is necessary to increase the Metsuke of the unwoven fabric to maintain the penetration resistance, so that the helmet is very difficult to be lightened.

[0010] As the above-mentioned other fibers, inorganic fibers such as carbon fibers and glass fibers, high-strength organic fibers such as aramid and total aromatic polyester fibers, common industrial material fibers such as polyamide, polyester, vinylon, etc., are mentioned. Among these fibers, a hybrid unwoven fabric composed of glass fibers and said high-strength polyethylene fibers or a combined-filament unwoven fabric of vinylon fibers and said high-strength polyethylene fibers has excellent impact resistance and excellent adhesion with a thermosetting resin being used in impregnating and curing. In particular, the combined-filament unwoven fabric with the vinylon fibers with a small specific gravity is preferable since an excellent effect is also obtained in the lightness. The fiber length of these other fibers is not particularly limited, however if the fiber length is preferably 30 mm or more, effective effect can be given to the present invention.

[0011] As the unwoven fabric being used in the present invention, an unwoven fabric with a Metsuke of usually 150-400 g/m^2, preferably 200-300 g/m^2 is used. If the Metsuke is less than 150 g/m^2, even if the unwoven fabric is 100% high-strength

polyethylene fibers, the strength is deficient, and the penetration resistance tends to be unsatisfactory. On the contrary, if the Metsuke is more than 400 g/m^2, even if the ratio of the polyethylene fibers is 50%, the entire fabric is bulky, though the penetration resistance is sufficiently satisfactory, so that the thickness of the hat body is thickened. Thereby the goal of the lightness tends to be unable to be achieved.

[0012] Also, as the bulk density of the unwoven fabric, the bulk density measured as a compressive load of 5 kg/cm^2 is appropriately 0.3 g/cm^3 or less, preferably 0.2 g/cm^3 or less. If said bulk density is more than 0.3 g/cm^3, for example, when an unwoven fabric with a Metsuke of 150 g/m^2 is used, the thickness of the laminate is 0.5 mm or less, so that the average thickness of the entire hat body is 2.5 mm or less. Thereby, the impact resistance tends to be unable to meet the determined standards.

[0013] Though the thickness of the unwoven fabric is not particularly limited, the thickness that does not hinder the lightness of the helmet or the impact resistance of the hat body of the helmet is preferable. From such a viewpoint, the thickness of the unwoven fabric is usually about 4 mm or les, preferably about 3 mm or less.

[0014] The unwoven fabric is formed at a desired thickness and size by mixing the above-mentioned high-strength polyethylene

fibers with a prescribed fiber length with other fibers at a prescribed ratio, if necessary, according to a well-known method such as card web lamination.

[0015] In the laminate of the glass fibers and the unwoven fabric, glass fiber layers are formed on one surface or both surfaces of the above-mentioned unwoven fabric. This laminate is generally called a perform mat and is formed by depositing and fixing the glass fibers at a desired thickness by a known method so that the glass fibers may be fitted to a helmet shape. For example, an enlarged cross section of a part A of the hat body of the helmet shown in Figure 1 is shown in Figure 2.

[0016] Though the thickness of the glass fiber layer is not particularly limited in relation to the thickness of the above-mentioned unwoven fabric, the thickness in the range where a laminate in which the lightness of the helmet can be achieved and the impact resistance standard being set to the hat body of the helmet can be met is obtained is preferable. From such a viewpoint, the thickness of the glass fiber layer is usually about 1.0-3.0 mm, preferably about 1.5-2.5 mm.

[0017] The hat body of the helmet is formed by a laminate being constituted by impregnating and curing a thermosetting resin. The impregnation of the thermosetting resin is carried out by a method that immerses the laminate into a thermosetting resin

solution, a method that sprays a thermosetting resin solution on the laminate, etc. As the thermosetting resin, for example, unsaturated polyester resin, vinyl ester resin, epoxy resin, etc., are mentioned.

[0018] The helmet is manufactured by molding the laminate being constituted by impregnating and curing the above-mentioned thermosetting resin into a hat body with a prescribed shape and size by a known method such as pressure bag molding method and matched die molding method.

[0019]

(Application examples)

Application Examples 1-9 and Comparative Examples 1-10

As shown in Table I (application examples) and Table II (comparative examples), helmets were prepared by a pressure bag molding, and the performances of the helmet were tested according to SNELL M90. The results are shown in Tables I and II.

[0020]

(Table I)

/4

Sample No.	Unwoven fabric					
	Unwoven fabric material	Polyethylene fiber contents		Metsuke	Compressive thickness (5 kg/cm^2)	Bulk density
	Material	Fiber length (mm)	Volume rate(%)	g/m^2	mm	g/cm^3

Application Example 1	Polyethylene	25	100	255	1.56	0.16
Application Example 2	Polyethylene	51	100	253	1.62	0.16
Application Example 3	Polyethylene	78	100	249	1.60	0.16
Application Example 4	Polyethylene	51	100	186	1.35	0.14
Application Example 5	Polyethylene	51	100	369	2.02	0.18
Application Example 6	Polyethylene + vinylon	51	80	267	1.68	0.16
Application Example 7	Polyethylene + vinylon	51	60	287	1.94	0.15
Application Example 8	Polyethylene + glass fibers	51	75	351	2.11	0.17
Application Example 9	Polethylene + glass fibers	51	55	380	2.72	0.14

Helmet				SNELL M90 test results		
Amount of glass mat	Number of Unwoven Fabric	Average thickness	Hat body weight	Impact Resistance (less than 314G pass)		Penetration resistance
g	Sheet	mm	g	G value at 1st cycle	G value at 2nd cycle	
308	1	3.0	603	141	144	Pass
286	1	3.0	610	136	145	Pass
299	1	3.0	606	130	147	Pass
292	1	2.9	580	178	205	Pass
308	1	3.2	645	127	130	Pass
287	1	3.1	617	147	152	Pass
286	1	3.2	639	151	142	Pass
298	1	3.3	657	158	162	Pass
286	1	3.6	721	166	149	Pass

Note) In this table, the polyethylene fibers means "high-strength polyethylene fiber."

[0021]

(Table II)

Sample No.	Unwoven fabric					
	Unwoven fabric material (Comparative Example 7 is a woven fabric)	Polyethylene		Metsuke	Compressive thickness (5 kg/cm^2)	Bulk density
	Material	Fiber length (mm)	Volume rate(%)	g/m^2	Mm	g/cm^3
Comparative Example 1	Polyethylene	15	100	248	1.22	0.20
Comparative Example 2	Polyethylene	100	100	255	1.40	0.18
Comparative Example 3	Polyethylene	51	100	420	2.50	0.17
Comparative Example 4	Polyethylene	51	100	126	0.51	0.25
Comparative Example 5	Polyethylene	51	100	239	0.71	0.34
Comparative Example 6	Polyethylene + vinylon	51	10	290	1.77	0.16
Comparative Example 7	Polyethylene + vinylon	51	40	271	1.48	0.18
Comparative Example 8	Polyethylene + glass fibers	51	90	254	1.32	0.19
Comparative Example 9	Polethylene woven fabric	–	100	252	0.78	0.31
Comparative Example 10	–	–	–	–	–	–

Helmet				SNELL M90 test results	
Amount of glass mat	Number of Unwoven Fabric	Average thickness	Hat body weight	Impact Resistance (less than 314G pass)	Penetration resistance

g	Sheet	mm	g	G value at 1st cycle	G value at 2nd cycle	
294	1	2.8	617	149	126	Fail
297	1	2.9	634	138	194	Pass
297	1	3.5	752	122	115	Pass
298	1	2.5	540	243	389	Fail
301	1	2.9	638	201	324	Pass
286	1	4.0	867	169	153	Fail
292	1	3.8	825	153	170	Fail
286	1	3.6	774	153	198	Pass
296	1	3.0	664	141	192	Pass
460	-	2.4	758	249	322	Fail

Note) In this table, the polyethylene fibers means "high-strength polyethylene fiber."

[0022] Table III shows the properties of the fiber materials used in the above-mentioned experimental examples.

[0023]

(Table III)

/5

Material	Specific gravity	Strength		Elastic Modulus	
		GPa	g/d	GPa	g/d
Polyethylene	0.97	2.84	33	98	1150
Vinylon	1.28	1.38	12	28	250
Glass fibers	2.54	2.45	11	69	306

[0024]

(Effects of the invention)

As also seen from the above-mentioned experimental results, the helmet of the present invention has excellent repeated

impact resistance and excellent penetration and impact resistance while it is sufficiently lightweight. Therefore, when the helmet of the present invention is put on, the load of the head of a wearer is lightened, and the head can be strongly protected from an impact being applied by vehicle accidents. Accordingly, the present invention can contribute greatly to the protection of the human life.

Brief description of the figures

Figure 1 shows a hat body of the helmet of the present invention.

Figure 2 is a partially enlarged cross section showing the hat body of the helmet of the present invention.

Explanation of numerals:

1 Unwoven fabric containing high-strength polyethylene fibers

2 Glass fiber layer

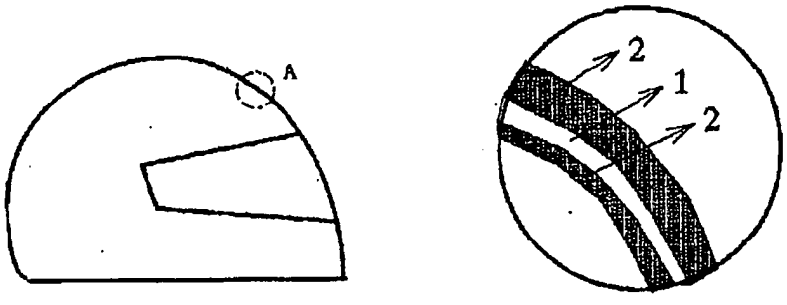

Figure 2:

1 Unwoven fabric containing high-strength polyethylene fibers

2 Glass fiber layer